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**PORTO RICO AGRICULTURAL EXPERIMENT STATION,**  
**D. W. MAY, Agronomist in Charge,**  
**Mayaguez, P. R.**

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**Under the Supervision of the STATES RELATIONS SERVICE,  
Office of Experiment Stations, U. S. Department of Agriculture.**

**REPORT OF THE PORTO RICO  
AGRICULTURAL EXPERIMENT  
STATION.**

**1919.**



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## PORTO RICO AGRICULTURAL EXPERIMENT STATION.

[Under the supervision of A. C. TRUE, Director, States Relations Service, United States Department of Agriculture.]

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## LETTER OF TRANSMITTAL.

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PORTO RICO AGRICULTURAL EXPERIMENT STATION,  
*Mayaguez, P. R., December 15, 1919.*

SIR: I have the honor to transmit herewith and to recommend for publication a report of the Porto Rico Agricultural Experiment Station, 1919.

Respectfully,

D. W. MAY,  
*Agronomist in Charge.*

Dr. A. C. TRUE,  
*Director, States Relations Service,*  
*U. S. Department of Agriculture, Washington, D. C.*

Publication recommended.  
A. C. TRUE, *Director.*

Publication authorized.  
E. T. MEREDITH,  
*Secretary of Agriculture.*

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<sup>1</sup> Appointed Feb. 28, 1920.

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# REPORT OF THE PORTO RICO AGRICULTURAL EXPERIMENT STATION, 1919.

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## REPORT OF THE AGRONOMIST IN CHARGE.

By D. W. MAY.

### INTRODUCTION.

The experiment station in Porto Rico continued to devote its energies to solving the most pressing food problems which arose as an outcome of the war, and most of its major work consisted in finding ways and means to increase the supply of food needed for home consumption. The menace of a scarcity of staple imported foodstuffs was keenly realized, especially during that crisis when one of our largest ships was sunk by a submarine, and as a consequence lessons in conservation and in the home production of hitherto imported foodstuffs were very welcome. It is believed that as a result the production of home-grown crops will become more of a fixed habit. The work of the extension division was continued under favorable conditions, and it has been shown that a wide range of crops can be grown in Porto Rico with considerable profit to the producer.

During the twenty years of the American occupation in Porto Rico agricultural production has increased tremendously, due principally to the development of large areas as single units. There seems to have been little or no departure from this tendency, despite the fact that efforts along educational lines and through legal enactments have been made to curtail large land holdings. Instead of cutting down large holdings, they have actually been increased through purchase or under long leases.

The manufacturer of sugar requires a large capital if he would profit by foreign trade. The coffee planter, on the other hand, often has other industries to fall back on financially. He is therefore better able to finance and export his products. A fruit growers' association has been formed to market the fruit, secure shipping facilities, and to handle by-products at a profit. These facts serve to prove that there is a tendency among agriculturists in Porto Rico



to combine into large units, either by purchase or lease, or by combinations to standardize and stabilize grades and markets and to buy and sell cooperatively.

Life in the Tropics is comparatively easy. The small cultivator is, as a result, usually more or less indifferent to anything other than obtaining a bare subsistence. No doubt in many lines he can produce more at a less cost than the larger planter, for his overhead expenses are much lower. On the other hand, the large planter or manager of a corporation thoroughly studies his business, and, although the actual cost of his production may be higher, his return is greater and nets him a quicker gain over cost.

Throughout Porto Rico the trees have been cut from the land, and the soil has been much depleted by persistent agricultural practice which considers only present profits. Sugar and coffee have been the leading crops of the island. Sugar continues to lead, this industry having been fostered since the American occupation by a protective tariff. Coffee probably has reached the summit of its importance as an industry and is on the decline. Unless aided artificially, Porto Rico can not produce coffee in competition with other countries.

Tobacco growing is attaining a greater success, not necessarily through larger production but through improved methods of curing and by reason of the fact that a large percentage of the population is skilled in cigar making.

Fruit growing, an industry introduced since the American occupation, is rapidly developing and gives promise of becoming the leading industry in the course of time. Fruits closely rival coffee and tobacco for second rank in exports, and with sugar now form the great bulk of the cargoes exported from Porto Rico.

#### SUGAR.

The exports of sugar vary from year to year with the prices. When the price of sugar is high, lands which ordinarily remain idle and unprofitable are planted to sugar cane. When prices fall, these lands go back to pasture. The area planted to sugar cane in Porto Rico is relatively large at the present time of high prices.

A threatening cloud is always on the sugar horizon. Just now it is the so-called mottling disease, having the appearance and habit of a mosaic disease. This has greatly reduced the production of sugar in some sections of Porto Rico. Fortunately, however, some varieties of cane are wholly or partially resistant. Among these is the Kavangire, which, since its introduction by this station several years ago, has been widely distributed over the island. (Pl. I, fig. 1.) This cane, though immune, is not of high quality. It stools well, but the stalk is of small diameter, and its fiber content and cost of



harvesting and milling run high. The Kavangire averages about 12 per cent sucrose and 80 per cent purity.

Some other and better varieties of seedling canes, while not wholly immune to the disease, not only are not seriously damaged by it but make a good growth in spite of it. By the use of these varieties and by frequently changing the seed and eliminating diseased stools, this disease can be controlled and perhaps exterminated. Considerable work has been done to determine whether the disease is borne by an insect. Up to the present no evidence has been secured to prove this to be the case.

The station again urges the employment of a more rational system of rotation in cane growing, and the use of other crops, especially a legume, in the cycle.

### FRUITS AND VEGETABLES.

The fruit industry, developed since the American occupation, has had a precarious career. Fruit growers have come from all walks of life, many desiring homes where the outdoor life, plants, and the climate appealed to them, and others representing companies organized in the States to seek a profit. Others, again, were promoters and adventurers from whose operations the island and the fruit interests will not recover for years to come. The growing of fruit is precarious and requires constant and unremitting attention. The gains accruing therefrom are sometimes large, yet losses from unforeseen causes must be continually fortified against. In Porto Rico the growing of fruit has been a pioneering industry, and the experience gained in other countries has proved of little or no value to the fruit grower in Porto Rico. A number of groves are now producing well, others only small amounts, and many are complete failures.

Porto Rico is now in the second stage of the industry. Since necessity is driving them into organization and cooperation, the producers are thrashing out the problem of successful marketing. The Fruit Exchange, the first cooperative organization among the people, has been in operation for several years, though it is experiencing the various vicissitudes that beset all such endeavors.

The third stage in fruit growing now receiving attention is the utilization of by-products. Bottled grapefruit juice is now on the market and is being favorably received.

### CITRUS FRUITS.

Little was done on citrus scab owing to the fact that the station was without a pathologist during the greater part of the year. Observations on this disease and its progress, however, are being made. It seems to be more prevalent where the leaf growth is greatest, and in groves which are hidden from the sunlight until late in the morn-

ing. Other studies now being made are those of the thrips which are found on the leaves, the influence they exert, and the probable damage caused by them. Cover crops for citrus plantations are receiving considerable attention, especially the more luxuriant kinds, such as velvet bean and *Crotalaria*, which, in addition to storing nitrogen in the soil, provide sufficient growth for humus and for mulching. Mulching as a substitute for cultivation is being tried out with some interesting results. Experiments conducted to determine the effect of fertilization on citrus trees are also receiving considerable attention. The matter of testing windbreaks for citrus trees continues to be one of much importance, and a number of additional species of trees are under trial for this purpose. These are leguminous trees, which are proving far more valuable than bamboo and trees of other orders. Records are being kept of citrus trees growing on a number of plantations, and fruit growers are being urged to secure budwood from the best bearing trees and to propagate these trees.

#### MANGOES.

Returns are beginning to come in from the hundreds of improved mangoes sent out by the station. These fruits are now found in the markets of the island and some shipments of them are beginning to go to the New York market. Several more of the new varieties of mangoes fruited during the year. The station is planning for the standardization of this fruit and for the extended propagation of the more promising varieties.

#### AVOCADOS.

The growing of avocados is steadily increasing, and the station has under trial a number of varieties which are well suited for shipping purposes. A great deal of this fruit is sold in Porto Rico, and it has been a mistake not to greatly increase the business of exporting it. To that end the station is working along two lines: First, to grow varieties that will stand shipping; and, second, to develop shipping methods which will enable the fruit to reach the mainland markets in good condition. Unfortunately, at present, refrigeration methods are lacking on ships, and until that deficiency is remedied the station will be unable to ship the native avocados even though they are of excellent quality. With improved shipping facilities and the development of better methods for preserving foods while in transit, avocado growing is destined to become an industry of considerable importance.

#### YAMS.

Introduced varieties of yams, which have proved of value, have been distributed in 75 municipalities of the island.





FIG. 1.—KAVANGIRE CANE. RESISTANT TO MOTTLING DISEASE.



FIG. 2.—DAIRY CATTLE PASTURING AMONG MAHOGANY TREES 13 YEARS OLD.



at  
a  
th  
th  
in  
v  
f  
p  
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j  
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h  
c

### COCONUTS.

Regions devoted to the growing of coconuts have been extended, and the trees grown on the low, sandy beach lands, which are best adapted to this purpose, are already bearing. It has been found also that coconuts can be produced at a profit on certain lands away from the sea. The many uses to which the coconut can be put are increasing from year to year. This fact, in conjunction with that of the very little trouble and expense involved in the growing of coconuts, forms splendid inducements to further the planting of the coconut palm. A fertilizer test that has been in progress for four years with young palms has carried them to the time when the plants are just beginning to blossom. Older trees of which individual records have been kept are now yielding results.

### CACAO AND COFFEE.

Individual records of cacao trees are being continued. The station has also under trial a number of the best varieties of cacao from other countries.

Fertilizer, variety, and pruning tests with coffee have been uninterrupted. Varieties of shade trees not locally used are also being tried out for coffee. In general an improvement in yield in coffee has been noted as the result of better cultivation and pruning. During the war period, prices of coffee in Porto Rico were low, though those of almost all other crops increased. At the present writing, however, a change is taking place, and better prices are being paid for coffee. Prices are steadily rising, and the indications are that a very large crop will be produced during the present season.

### VANILLA.

Work with vanilla is showing excellent results. During the year a comparative test with different chemical and organic fertilizers was begun. Records are being made of the effects of pod production on the yield of vanilla beans, and on the yield of succeeding crops from the same plant. A number of processes for curing vanilla were tested, and various striking differences in the appearance of the cured beans and in the development of vanillin crystals were noted. Numerous vanilla cuttings supplied to different planters are now under trial in various sections of the island. The plantings are from 1 to 10 acres in extent, and indications are that vanilla will become one of the standard industries. The station considers vanilla especially valuable as an aid to coffee growers, as it not only gives them an additional profit from their plantations but also assures them of a yearly income.



## ORNAMENTALS.

The introduction, propagation, and distribution of various plants of ornamental value have been furthered. Although the work of the station has been heretofore mainly along economic lines, the point has at last been reached where more attention can be given to the cultivation and distribution of ornamentals. Porto Rico is becoming more popular as a winter resort, and its many natural attractions should be improved.

## RICE, BEANS, AND CORN.

A great deal of attention has been given to the cultivation of rice, and strong efforts have been made to induce the planters to grow more of this food, which is Porto Rico's greatest import. The food of the Porto Rican consists largely of rice and beans. Though beans are now grown in sufficient quantity to supply local needs, there is a necessity for growing more rice. Moreover, many of the lands which now produce cane should be thrown into some system of rotation. Rice promises to be one of the best plants for this purpose, as it not only improves the soil but also produces a crop of considerable value and one that should yield a profit.

Tests of the comparative productiveness of various garden and field beans and pigeon peas are under way, and a number of these legumes have been distributed throughout the island. Much attention has been given to the growing of Lima beans and especially to testing some which contained considerable amounts of hydrocyanic acid. In this connection some work has been done in cooperation with the Bureau of Chemistry, United States Department of Agriculture, and as fatal poisoning in the island has resulted where certain varieties of Lima beans were eaten information regarding the identification of these varieties has been disseminated.

Besides the better known kinds of beans, the station is endeavoring to promote a great increase in the growing of soy beans. This bean is especially valuable, as it is very rich in fat, that element being too frequently lacking in amount in the dietary. The growing of soy beans promises to be quite successful. Cowpeas are also being grown in increasing amounts. Some introduced varieties of the station are especially popular. The mung bean of the Philippines has been introduced and is gaining in favor. It grows under very adverse conditions, improves the soil, and makes a very nutritious food. A great deal of work has been done in the improvement of corn. The station has found that the best way to improve the corn crop is to develop some of the acclimated varieties.



### LIVE STOCK.

Live stock is increasing in numbers and especially in quality. Purebred sires are imported each year from the States, so that the improvement is constant. The raising of dairy cattle is receiving the greatest attention. (Pl. I, fig. 2.) Two years ago the station erected the first dipping tank, and all cattle brought to it are dipped free of charge. The success gained from this work has induced planters in various sections of the island to build dipping tanks and periodically to dip all their cattle. The beneficial effects are very apparent. What is most needed now is a sufficient fund with which to inaugurate and conduct a definite campaign of attack to exterminate the tick which prevails throughout the island; then, by quarantine regulations, to keep it out. No money expended will yield a greater return to the people of Porto Rico than an amount sufficient to eradicate the cattle tick. This will eliminate the necessity of repeated dippings of cattle, and the adoption of proper quarantine regulations will keep the tick out of Porto Rico.

### REFORESTING.

The larger portion of the lands of Porto Rico is not cultivated. These uncultivated lands, though not waste, produce very scanty pasturage. The station aims to find the crop or crops best adapted to every parcel of land in the island, so that all land may be made productive. Farmers are often greatly discouraged by the fact that they do not know what to plant on these lands so that a profit can be obtained from them.

On the mountain known as the Mesa, above Mayaguez, the station has 200 acres of land which has been cut over for many years and has become very sterile and gullied. Such lands should, as a first step, be planted to legumes to make them an agricultural success. The velvet bean and *Crotalaria* greatly improve these lands when planted in the first season. Experiments so far conducted by the station indicate that by a rotation with legumes these old lands can be made profitable. This land is typical of a large acreage of the island. On cut-over hillsides, the following trees have also given indication of success: Camphor, avocado, mahogany (Pl. I, fig. 2), and some lesser known native woods of economic value.

The eucalyptus is now found in all sections, small trees and seeds grown at the station having been distributed to all parts of the island. As a science and art, forestry is receiving increasing interest among the people. Many trees are being planted at the schools and around the homes in spite of the fact that no extended planting of trees, other than fruit trees, has been made.



## FIBERS.

Among fiber crops sisal, henequen, jute, flax, and hat fiber are receiving the most attention. A machine for extracting fiber from the sisal was installed at the station during the year. A number of plantings have been made in various sections of the island, including one which covered over 500 acres. The weaving of baskets, hats, and mats is on the increase. The value of hats exported from the port of Mayaguez has amounted to over \$500,000 annually for several years. Most of these hats are made from the native straw and are not of the highest quality. The station has introduced and is extending the planting of the *Carludovica palmata*, from which the Panama hat is made. It aims to change in a few years the hat-weaving industry by the use of this kind of fiber to the exclusion of the native palm. A hat worth twice the value of one made from the native straw can be made with the same amount of labor. The process of growing and bleaching the straw of the *Carludovica* for hat weaving has been greatly fostered by the station. A campaign was made throughout the hat districts during the year to show methods of preparing and bleaching the straw.

The results obtained from the successful growing of flax during the last three years give promise of this becoming a new lucrative crop for the island. One of the largest firms producing flax has growing near Mayaguez 50 acres of flax for the production of seed, which will be sown in the States in the summer. The production of seed of such improved strains has led to the conclusion that Porto Rico may also be able to produce the fiber at a profit, as the climate lends itself to the retting of the flax.

## PLANT BREEDING.

When a new plant is introduced at the station and has proved itself to be worthy of further trial specimens are disseminated as rapidly as possible throughout Porto Rico. Plant-breeding work is carried on by the station not only by selection but by crossbreeding. Probably no other line of endeavor has given such great results as this. Plants which a few years ago were entirely new to the island are now found in all sections. Planters appreciate this successful propagation and cooperate readily with the station whenever it has something new to recommend to them. Among the more valuable introductions receiving special attention during the year were the velvet bean, *Crotalaria juncea*, and Napier or elephant grass (*Pennisetum purpureum*). Some very important work has been done also in distributing throughout the plantations varieties of canes which are resistant to the mottling disease now threatening the cane industry.



While considerable work is being carried on in the island to determine the cause of the disease and to secure general data regarding it, the most logical way to combat the disease appears to be the growing of immune varieties. The station has two or three varieties that are very promising in this regard and has imported more for extended planting from the station in St. Croix, Virgin Islands.

#### CHEMICAL INVESTIGATIONS.

Studies on the effect of green manuring and the use of fertilizers on the yield of cane and on the conservation of nitrogen in the soil are under way, and different crops are showing some variation in composition as a result of the fertilizers applied. The tolerance of several classes of plants to acidity in the soil has been noted during the year. Investigations are being continued to determine the need of phosphates in the soils of Porto Rico, and the value of various forms of phosphates when applied as a fertilizer. These studies cover typical soils from various sections of the island, and are carried out in the plant house, where all the factors which enter into the growth of the plants can be controlled.

#### MINOR INDUSTRIES.

While the larger industries of Porto Rico are prospering, the steady increase in population necessitates the development of smaller agricultural products and manufactures. This station from its inception has sought to foster especially the interests of the small landholder and the farm laborer.

Among the small industries beekeeping, which was first exploited by the station 12 years ago, has grown enormously. During this fiscal year the exports of honey and wax amounted to \$682,380.

The station is constantly called upon to show beekeepers the necessity and advantage of upgrading their stock by the frequent use of purebred queens, and it is also cooperating with them in the matter of introducing more honey-producing plants.

#### EXTENSION WORK.

The extension work of the station continues to receive a great deal of attention. Members of the staff visited various plantations and held conferences with the planters. As direct results the correspondence has steadily increased from year to year, and clearly indicates the healthy, growing interest in the work of the station.

In order to keep in closer touch with some of the industries, especially fruit growing, which is conducted on the northern side of the island, the station maintains an office in the Federal Building at San



Juan. This office issues a series of publications known as Agricultural Extension Notes. These publications convey information gathered by different members of the staff from investigations and from observations made on their travels over the island. The results of agricultural research work in other tropical countries are also reviewed from time to time and brought to the attention of the planters. The Agricultural Extension Notes are issued in both English and Spanish and have a wide circulation. That these publications have materially increased the usefulness of the station is evidenced by the many inquiries and requests which are frequently received from planters in all sections of Porto Rico.

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## REPORT OF THE CHEMIST AND ASSISTANT CHEMIST.

By L. G. WILLIS and J. O. CARRERO.

### AVAILABILITY OF PHOSPHATES.

Investigations to determine the relative availability of different phosphatic fertilizers and the phosphate requirements of the principal types of soil found in Porto Rico were carried to completion by the assistant chemist, and the results are now being prepared for publication.

The greater part of the past year was occupied in developing plans for continuing the work of the department. This necessitated a study of the agricultural resources and practices of Porto Rico, as well as of the results obtained in investigations at the station and by tropical investigators elsewhere. The chemist made several trips to different parts of the island to become familiar with soil types and crops, and to make such other observations as were necessary before any work of local value could be undertaken.

### NITROGEN ECONOMY IN CANE SOILS.

As nitrogen is apparently the fertilizing element which is the limiting factor in cane production, plans were developed for a quantitative study of the nitrogen balance in soils on which cane is grown. Special attention is being given to leguminous green-manure crops to determine the extent to which they can supply the nitrogen required for cane culture. The major part of this investigation is being conducted on a series of 36 plats, each of which is planted to cane and so arranged as to furnish results under three systems of cropping. All plats are to be uniformly fertilized with liberal amounts of potash and phosphate, nitrogen being supplied in the form of nitrate of soda, sulphate of ammonia, and through the agency of a green-manure crop.

In addition to the 36 plats planted to cane, 12 smaller plats are being used, 6 of which will be kept bare, while the remainder will be allowed to grow the native vegetation, in order to compare the nitrogen content of soil so treated with that of soil of cropped plats.

It has been planned to supplement the results of the field experiments with data from pot experiments now being conducted, and work was started to determine the extent to which the accumulation of nitrogen by certain leguminous plants can be carried when drainage is eliminated and moisture is maintained at the optimum.

Obviously, these experiments must extend over a period of several years, since the analytical differences obtained in two or three consecutive years will be too small to be of any significance.

#### OTHER INVESTIGATIONS.

In addition to the study of nitrogen economy in cane soils, plans were made to investigate certain phases of plant nutrition, particularly the nature of the reactions of plants toward acid soils. The problem of soil acidity has been considerably clarified recently by the work of a number of investigators, and some of the latest hypotheses are significant, especially when applied to local conditions.

An attempt is also being made to supplement certain analyses which treat of the effect of fertilization on the composition of a crop, in order to learn whether an apparently uniform relation holds true invariably. A large amount of material is already available, but it is thought that a few additional determinations will suffice to indicate whether the problem is one deserving of further investigation.

#### MISCELLANEOUS ANALYTICAL WORK.

Continuing the policy of other years, analyses of miscellaneous samples of materials sent to the station were made whenever it was apparent that the information obtained therefrom would be of general agricultural value. A number of analyses were made to supplement the work previously done by other members of the station staff, the larger number of determinations being of sugars from variety plats of cane, and of vanillin developed in vanilla beans by different methods of curing.

An unproductive soil found near Dorado, representative of a considerable area, was studied to determine the cause of crop failures on the tract. An analysis of a typical sample indicated no lack of sufficient nitrogen, phosphate, or potash, but showed the content of lime and magnesia to be unusually low and the lime requirement very high. When rice was used as a test crop in a pot experi-



ment of limited scope, it was found that liming or leaching decreased the amount of growth, but that a notable increase above the yield on the untreated soil was produced when treated with lime, phosphate, and potash. It is thought that where there was an absence of sufficient lime in the soil the phosphate, added to fertilize the field crop, had been rendered unavailable by reaction with iron, and that the rational plan for improvement is to heavily lime the soil, and thereafter to apply phosphate and potash in liberal amounts. This treatment has been recommended for a series of test plats in the field. The possibility that toxic aluminum compounds might have been partly responsible for the poor crop was considered, but, since it apparently was not the major cause of the trouble, no attempt was made to settle that phase of the problem.

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## REPORT OF THE HORTICULTURIST.

By T. B. McCLELLAND.

### MANGOES.

In the last two seasons 14 seedling trees from grafted Cambodiana mangoes fruited. Of these, 7 came true to the parent type. The others differed in several of the characteristics, including color, shape, size, texture, sweetness, flavor, fiber, quality, shape, and veining of the seed. In the accompanying illustration (Pl. II, fig. 1) the parent type is shown in the center with variant forms of seedlings on either side. The one at the right was a large fruit which weighed from three-quarters to more than a pound, and was sweet and agreeable in flavor. Its only objectionable characteristic was the considerable amount of fiber, which was found principally along the ventral margin. The mango at the left differed greatly both from that just described and from the parent. It was a small fruit, ranging from a quarter to a half pound in weight; moreover, it was proportionately short, had a broad base and rounded apex, and its dorsal edge formed a nearly perfect semicircle. Though sweet and pleasing in flavor, its very abundant fiber causes this fruit to be placed among those of poor quality. Another marked difference was shown in the veining of the seed, which was raised rather than sunken like the typical Cambodiana. Seed of this variety should be planted, the trees which fruited in the last two seasons having given indications that Cambodiana seedlings equal in quality to the parent can be secured. Among those which differ from the parent type are found some variations which prove objectionable; other variations may not be so considered.

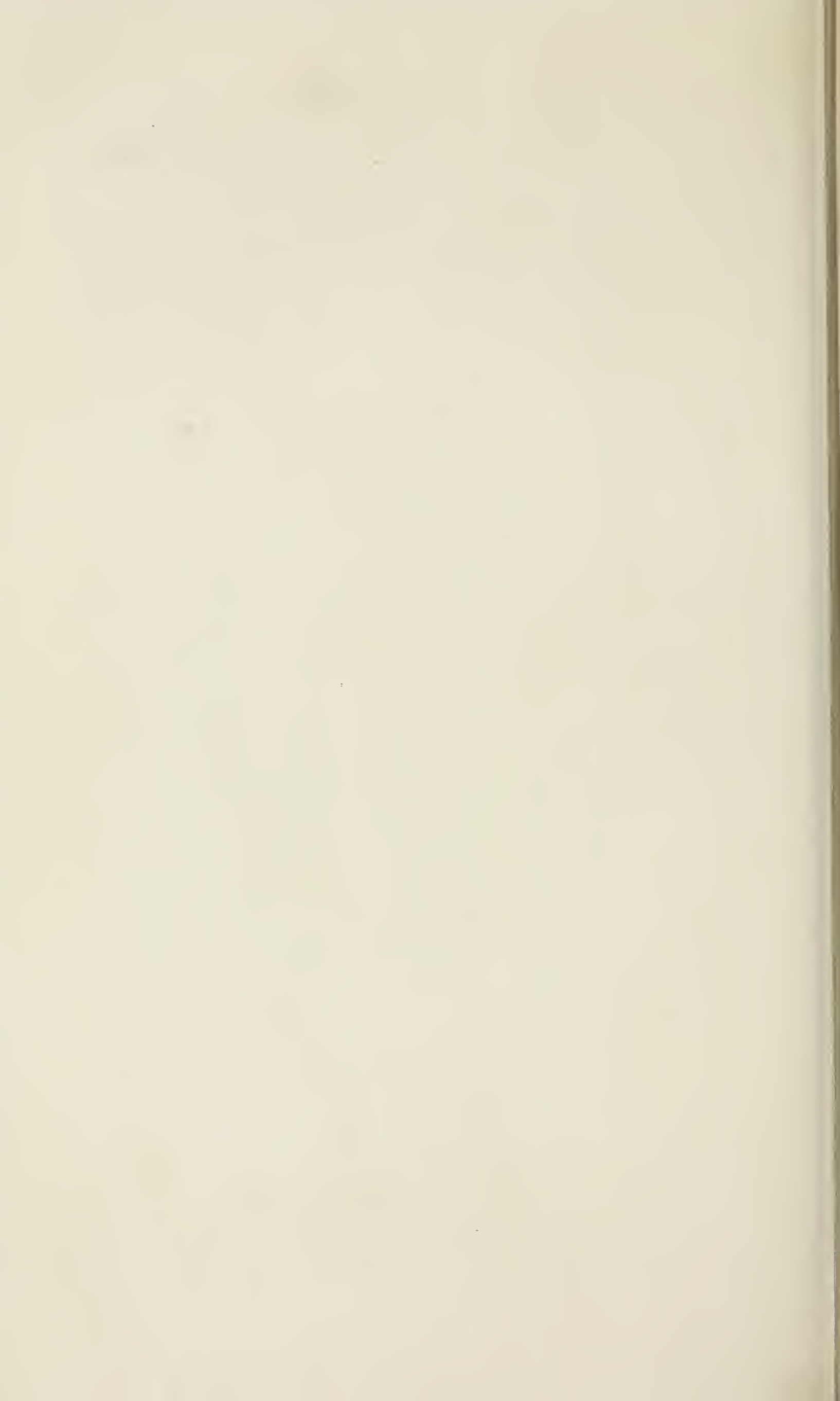




FIG. 1.—VARIATION IN SEEDLINGS OF CAMBODIANA MANGOES. TYPICAL FRUIT IN CENTER.



FIG. 2.—BRINDABANI MANGO (S. P. I. No. 10637).





Itamarca continues to show itself a very prolific producer of late fruit. For this reason it is especially valuable for lengthening the season, since its crop is matured after most of the other varieties are through fruiting.

Several varieties this season are fruiting for the first time, including Brindabani (S. P. I. No. 10637) and Fernandez (S. P. I. No. 19117), which, in September, 1910, were received as small inarched plants. The latter variety will mature its crop too late for the present report.

Brindabani produced a crop of about 225 fruits (Pl. II, fig. 2). These were borne in singles or in clusters of from two to eight. The form is almost spherical. Five fruits, which averaged 179 grams in weight, averaged in length,  $2\frac{5}{8}$  inches; in breadth,  $2\frac{1}{8}$  inches; and in thickness,  $2\frac{5}{8}$  inches. The stem, which is inserted squarely in the fruit, is about three-eighths inch long by three-sixteenths inch in diameter. The base of the Brindabani is flattened; the ventral shoulder is slightly the more prominent, and the cavity is broad, shallow, and slightly undulating. The apex is obtuse, the stalk inconspicuous, slightly depressed, and about an inch distant from the longitudinal apex. The surface is smooth, the color greenish yellow with a red blush, and the dots, which are moderately abundant, are small and straw colored. The skin is very thin, and in the ease with which it separates from the flesh, surpasses all varieties previously examined. In a fruit which weighed 202 grams, the skin weighed but 17 grams. The flesh is orange in color and very juicy. The fibers, which are green, are long and abundant near the base and near the ventral margin of the seed, along which they are connate at their base. The aroma of the uncut fruit is somewhat applelike. The flavor near the skin is pleasing and is reminiscent of that of the Concord grape. However, the acidity near the seed is too pronounced to be agreeable. The quality can not be considered more than fair. The seed is plump, obovate in outline, has a sharp, prominent beak and a slightly raised veining. In a fruit which weighed 157 grams, the seed weighed 19 grams and measured  $1\frac{3}{8}$  inches in length,  $1\frac{7}{8}$  inches in breadth, and three-fourth inch in thickness. It is monoembryonic. The crop matured throughout June and the first half of July. The fruit of this variety is very susceptible to disease, since very few fruits ripened in good condition and the major part were diseased, apparently with anthracnose. The foliage is less ornamental than that of many other varieties, the leaves being narrow and the branches delicate. The leaves are linear-lanceolate, some measuring as much as 9 by  $1\frac{3}{4}$  inches. Others are only half as long and a little more than half as broad.

Ground cork, in which grapes are imported in the holds of vessels from Europe, was tested as a packing for mangoes. Fruits, which



were picked in the morning, were left indoors on shelves until 4 p. m., when they were packed unwrapped in a box filled with ground cork. In from 20 to 36 hours after they were packed in a room where the temperature ranged between  $30.5^{\circ}$  and  $28^{\circ}$  C., respectively, the thermometer within the box registered  $36^{\circ}$  C., and the temperature rose to  $37^{\circ}$  C. within  $2\frac{1}{2}$  hours after the latter inspection. Under these conditions the ripening of the fruit was very rapid, and in a few crates so shipped to the States, approximately two-thirds of the fruits were found rotten on their receipt, 10 days after picking. Another, but well-ventilated crate, in which the fruits were wrapped in orange paper and packed with excelsior, and for which refrigeration was requested on the boat, showed a decay of only 8 per cent 10 days after shipment.

### VANILLA.

Two publications were issued within the year on the work with vanilla. One<sup>2</sup> suggests a partial explanation for the very marked ectogony which was observed to follow the crossing of certain species. The other<sup>3</sup> is practically a report of the progress of work which is being continued. Crop limitation as reported here showed its effect on the weight and size of the beans of a single crop. Now the effect is being shown on the capability of the vine for further production. The average yield in number of pods per vine for the 1917 crop was rated at 100 per cent for each group; that of the 1918 crop amounted to 114 per cent for the group in which the production was limited to 2 pods per cluster; 98 per cent for the group in which 4 pods developed per cluster, and but 76 per cent for the group in which 6 pods were borne per cluster. Each group showed an increase in weight of average production per vine and also an increase in size of average bean. These data show that where but two pods developed per cluster the vine made sufficient new growth for the production of a greater number of pods the following season. Neither of the other groups did this. The same relative sequence of groups as for the preceding crop was maintained in regard to the weight of the average production per vine and of the average pod.

It is considered desirable to learn as definitely as possible the appearance of the pod just prior to its splitting. Some pods become quite oily, while others do not. A number of pods which were labeled as soon as oiliness was observed were left on the vine until they began to split and were examined at frequent intervals. The interval between the time of labeling and the time at which the pod was last observed unsplit ranged from 4 to 55 days and averaged 27 days. The oiliness extended from about one-third of the pod's

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<sup>2</sup> U. S. Dept. Agr., Jour. Agr. Research, 16 (1919), No. 9, pp. 245-252,

<sup>3</sup> Porto Rico Sta. Bul. 26 (1919), p. 32.



length to nearly the whole. As maturity is approached the pod assumes a mellow appearance, as though the oil had soaked in.

That a short delay between the time of picking and curing may cause a large depreciation in the value of pods was indicated by a number which, after being picked, were placed on a table within doors. The following day the split pods were sorted out. Two days later nearly one-fifth of the remaining pods had split and more than one-half split within a week after they were picked. The reduction in weight of pods of different lengths on drying was found very uniform.

Considerable attention was given to investigating different methods of curing, an electric oven being used for most of the work. The varying factors studied included temperature, humidity, and duration of heating. Very striking differences were noted in the appearance of the cured beans and in the development of vanillin crystals, the results showing variations from lots in which no crystals whatever developed to others in which the beans were white and glistening under their profusion of crystals. Inasmuch as this investigation is to be continued in order that the results already obtained may be confirmed and amplified, it is hoped that a highly satisfactory method of curing vanilla by the employment of an oven can be worked out.

The root development of cuttings which were not in connection with soil or leaf mold has been reported<sup>4</sup> as observed up to 24 weeks after the cuttings were tied to upright slats. One year from the time of placing nine cuttings were still making active root growth in their endeavor to reach the ground. The roots developed by some equaled in length the cutting itself, two exceeded 4 feet, and but one cutting failed to develop roots. The nine cuttings which were not making active root growth were then removed from the supports and placed on the ground, the lower portion of each cutting being covered with damp leaves. By the end of the fifth week all had started new root growth.

Numerous vanilla cuttings have been supplied to interested people, and several private plantings which are being started on a commercial scale are doing well.

A comparative test with different chemical and organic fertilizers for vanilla vines was begun.

#### COFFEE AND CACAO.

Fertilizer, variety, and pruning tests with coffee are being continued. A number of coffees which were not tested here previously, or else tested on a very small scale, are now coming into bearing.

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<sup>4</sup> Porto Rico Sta. Bul. 26 (1919), p. 13.



At a little more than four years after date of planting the seed of Robusta coffee, which is now so largely grown in Java, it was found that a fraction over 60 per cent of the most favorably located trees were in production. This crop averaged nearly 2 liters of cherry coffee per fruiting tree. The production prior to this was almost nil.

Various leguminous trees, which hitherto have not been used, are now being tested as shade trees for coffee plantations in Porto Rico. One of these, *Gliricidia maculata*, is proving to be so satisfactory that the station has distributed some of it to coffee growers. It may be propagated by either seed or cuttings. As the leaves are small and the trees dwarf, the shade can be easily regulated by close planting at first, and, later, by eliminating superfluous trees. Plate III, figure 1, shows a young planting of Bourbon coffee shaded by this legume at less than three years from the time of placing the cuttings between each two coffee trees.

Individual records on the yields of cacao trees are being continued. In the youngest planting a little less than half of the trees fruited at five years from seed, and averaged a little less than six pods per tree. The production prior to this had been very small.

#### VEGETABLES.

The testing of the comparative earliness, productiveness, and suitability to local conditions of various garden and field beans was continued and enlarged by the addition of a number of varieties from the west coast of the United States. Two plantings, each containing more than 50 rows, were made. The December planting suffered from insect attacks, and, as a consequence, satisfactory data as to crop could not be obtained. The yields of the late February planting were diminished by drought. Otherwise they served well for comparison of varieties, and data were recorded for the individual plants. Lady Washington and Navy, which were not tested the preceding season, ranked with, or surpassed, some varieties grown locally. They did not, however, equal in yield the Porto Rican white bean, which was exceeded only by the black Venezuelan bean. Among the plants of the latter, which is of very late maturing habit, an early maturing strain has been found and is being propagated for testing.

A study in inheritance of color and in the yield of several strains of locally grown and imported pigeon peas is in progress.

Varieties of locally grown and imported Lima beans were planted, some of which, when analyzed by the Food and Drug Inspection Laboratory of the Bureau of Chemistry, United States Department of Agriculture, were shown to be rankly poisonous.

Several varieties of tomatoes were tested and Mack's Prolific (F. H. B. 23572) proved of excellent quality.





FIG. 1.—GLIRICIDIA MACULATA AS COFFEE SHADE. TREES LESS THAN 3 YEARS FROM CUTTINGS.

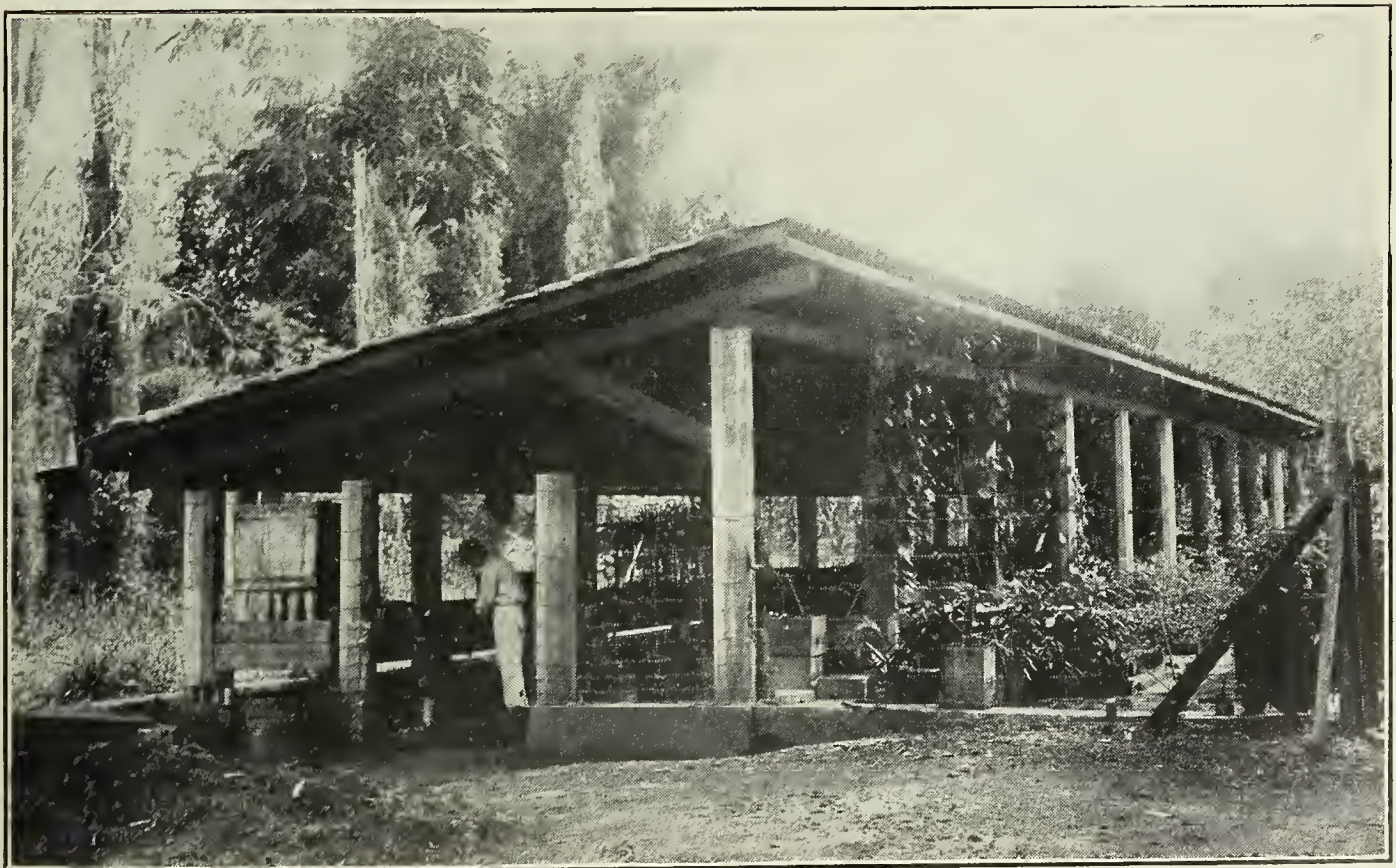


FIG. 2.—PROPAGATING HOUSE OF PORTO RICO STATION.





FIG. 1.—STAGE OF SEEDLING USED AND PREPARATION FOR GRAFTING.



FIG. 2.—GRAFTED AVOCADO SEEDLINGS GROWING IN POTS.



Yams of the more valuable introduced varieties were distributed in 75 municipalities of the island.

#### MISCELLANEOUS.

A fertilizer test has been running 4 years with young coconut palms which are just beginning to blossom. Records of production, which will show more clearly the period over which the fertilization was effective, are being continued on the older grove previously referred to,<sup>5</sup> and which has not received any fertilizer for some years.

A planting has been made of Guatemalan avocados. The station has been very successful in propagating avocados by grafting the desired variety on young seedlings as shown in Plate IV.

Attention is being given to the introduction, propagation, and distribution of various plants of economic or ornamental value.

A plant of *Thunbergia erecta* var. *cærulea* has developed a sporting branch in whose flowers the rich purple of this variety is replaced by lavender. As no printed mention of varieties other than *cærulea* and *alba* has been found, and as these are the only two which have been so far observed locally, it is thought that this new variety, which may be termed *lilacina*, is deserving of distribution. Several plants of this sport have already been propagated and distributions will be made later.

The propagating house shown in Plate III, figure 2, has proved well adapted to use in the Tropics. It consists of a tile roof borne on reinforced concrete pillars, and is open on all sides.

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#### REPORT OF THE ENTOMOLOGIST.

By W. V. TOWER.

##### MOTTLING DISEASE OF SUGAR CANE.

A number of experiments have been carried on with various cane insects to determine whether they transmit the so-called mottling disease of sugar cane. For these experiments, seed cane was obtained from a district comparatively free from the disease. This selected seed was planted in pots, which were immediately covered with cloth cages so that insects were unable to come in contact with the canes, and the plants were watered through the cloth. After the canes germinated and the young sprouts were 3 to 5 inches long, various cane insects from infected plants were introduced in the cages.

Immature mealy bugs (*Pseudococcus sacchari*) were introduced and became established in a number of pots. In other cases the mealy

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<sup>5</sup> Porto Rico Sta. Rpt. 1917, p. 21.



bugs were crushed and rubbed on the developing buds and shoots. Punctures were also made in the buds and shoots and the crushed mealy bugs were forced into the young canes, but in no instance did the cane develop the mottling disease.

A number of species of leaf hoppers found on infected cane were put into the cages in various stages of development and allowed to establish themselves until a second generation appeared. The cane, however, did not become infected with the disease.

A few sugar-cane moth borers (*Diatraea saccharalis*) were transferred from sickly to healthy plants by placing the borer under absorbent cotton. No infection appeared as a result.

A number of leaf-eating insects were fed in these cages, yet none of the cane developed the disease.

### HONEY PLANTS.

A daily record of the blossoming periods of the most important honey plants and trees is being kept. This will give data concerning the period of bloom of the various plants. The length of bloom and dates of blossoming being governed by the rainfall, on account of the climatic differences, the period of bloom will have to be determined for each district. During the fiscal year ending June 30, 1919, 3,817,031 pounds of honey, valued at \$666,457, was exported from the island.

### OBSERVATIONS ON CITRUS SCAB.

Scab still continues to be the worst pest to the citrus grower.

An excessive amount of nitrogen in the soil seems to have a marked tendency to produce scab in young groves. Trees that are growing fast and have rank, luxuriant growth are more susceptible to scab than those which are making more moderate growth. It is thought that trees which have produced excessive amounts of scabby fruit during their early growth will, when they slow down, produce clean, handsome fruit, and that old trees which have been given an extra application of fertilizer running high in nitrogen will produce coarse and scabby fruit. This point will have to be determined by fertilizer experiments. Furthermore, it is not believed to be advisable to make heavy applications of quick-acting fertilizers just previous to the blooming period of the tree. This will have to be governed by the nature of the previous crop and the present condition of the tree. For instance, if the grove, taken as a whole, has not produced a heavy crop during the year and the trees have developed one or two strong growths, it would be better not to make too heavy an application of quick-acting fertilizer containing a high percentage of nitrogen. On the other hand, if the grove has borne an extra heavy crop, an



excess of nitrogenous fertilizer would probably be of great benefit to the trees and perhaps would not be conducive to scab. Therefore it seems more advisable to build up the tree during the year and to allow it to develop its normal bloom in the spring rather than to try to force an early bloom by the use of heavy applications of nitrogenous fertilizers.

It has frequently been noticed on inspection trips that reasonably old groves, which in previous years were considered free, were literally covered with scab. Upon inquiry, it was found that during the past season these groves had been plowed, and that heavy applications of nitrogen had been given, although plowing had not been practiced previously. This heavy early spring plowing cut off many of the large roots, and from those which remained thousands of small feeding roots started. These reached out into the newly plowed soil containing the highly nitrogenous fertilizer. The excessive resultant tree growth often is very succulent and susceptible to fungus diseases. Such conditions are modified where it is the practice to plow every year and to force down the feeding roots so that heavy flushes will be infrequent.

Various types of soil have marked influence on the presence or absence of scab. Very fertile soils which contain excessive amounts of humus produce trees more susceptible to scab than those which are grown on sandy soils poor in fertility and where the nutriment has been supplied in commercial fertilizers. Excessive amounts of high nitrogenous fertilizers on these sandy soils fail to produce the rank growth found on the first-mentioned type of soil.

In one of the plantations on the north side of the island some of the groves are located in pockets among the hills. The trees have always been well fertilized and thoroughly cultivated. Their leaves are very large and the foliage is heavy and rank. The crops have always been light and very scabby, due apparently to the fact that all their vitality has been used in developing large, strong trees. Since the trees were large enough to carry a four or five box crop, it was decided to cut down the supply of nitrogen in some of the pockets and to use just the usual amount of phosphoric acid and potash. These plans were carried out, with the result that there is now a very heavy crop freer from scab. The trees seem to be settling down, and the fruit is not developing in clusters, nor are the leaves large and succulent.

Neglected or worn-out groves do not generally have scabby fruit. The opening of trees by pruning may also help them to resist scab. The weather conditions have an important bearing on the amount of scab. Bloom that comes during a period of dry weather is generally free from scab, while fruit which appears during the rainy period is almost sure to be infected.



## WORK AMONG THE CITRUS GROWERS.

In furthering the citrus work of the station, practically all the larger groves on the island were visited during the year.

The following are lines of work in progress:

(1) The supplying of humus to old closed-in groves. A number of growers are testing plats with mulch, using cane trash and swale grass for the purpose, while others are raising velvet beans, which will be carried on to the ground, where they will act as a mulch and supply humus.

(2) The planting of leguminous trees as permanent windbreaks to take the place of the bamboo which was generally used in the early days. Some planters are using improved mango trees as permanent windbreaks.

(3) Cover crops to supply nitrogen and humus in young groves which have not closed in.

(4) Endeavoring to interest growers in the benefits to be derived from keeping individual tree records and in the importance of selecting budwood from trees whose records have been kept for a number of years. A few growers have been keeping tree records for budwood, but very few have been keeping individual tree records.

(5) Study of various methods of cultivation to note their effect on early bloom. Some groves which were in clean culture with a dust mulch blossomed, while others that were not worked and put in good condition did not bloom. Groves that were not plowed and covered with a dust mulch blossomed, but they did not hold their fruit.

It has been observed that fertilizer applied in December and January has a tendency to bring on early bloom and puts the trees in condition to hold the young fruit.

A small nursery of 1,000 trees has been planted at the station. These will be budded to the best varieties for distribution. Part of this stock will be used for tree-selection work.

Notes regarding growth and number of fruits per tree have been taken on the citrus stock experiment at the station. Budwood from standard varieties is being sent out from time to time.

## CITRUS THRIPS.

Reports on serious injury by thrips to oranges have been noted in California, Arizona, and Florida, and as these insects have been found in the citrus blossoms in Porto Rico, it was thought advisable to make a survey of the station groves to determine the thrips invasion. A survey on grapefruit was undertaken during its spring blossoming period. A daily record was kept of many trees on which a number of thrips were present. Counts were made each day for the



full period of the bloom in the three stages of flowering—fully open, just open, and partly open. It was found that there was present an excessive number of thrips. Some blossoms, containing over 25 thrips, were tagged. The average number of thrips for grapefruit bloom was 27. It was found that the averages for the fully open, just open, and partly open blossoms were practically the same. The greatest amount of infestation occurred just before the period of white bloom. The infestation during the heaviest bloom was very constant, but from this time on it decreased. At present practically no damage seems to have resulted, and all the grapefruit trees have borne a heavy crop.

Since these experiments on grapefruit were made, thrips marks have been found on oranges in some of the cultivated groves on the north coast, and also on wild oranges in the local packing houses at Mayaguez.

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## REPORT OF THE ASSISTANT IN PLANT BREEDING.

By W. P. SNYDER.

The work in plant breeding was resumed on December 30, 1918, when the writer returned from a leave of 11 months for military service. Some of the lines of work begun the preceding year were resumed and several new projects were taken up.

### VEGETABLES.

A planting of vegetables was made in the spring in order that seed might be obtained from them. The summer rains almost destroyed the root crops, but a planting of celery, which is still in fair shape, may produce seed in the coming winter.

Six rows of tomatoes were set out on May 11, including Greater Baltimore, Matchless, and a small native variety. The average production per plant was 1.45 pounds for the native, 1.06 pounds for Greater Baltimore, and 0.88 pound for Matchless. The average size of fruit was 1.8 ounces for the native tomato, 4.9 ounces for Greater Baltimore, and 4.3 ounces for Matchless. The poor results are due to the ravages of the *Cladosporium* fungus during wet weather. The native tomatoes are much less susceptible to this fungus than are introduced varieties. A cross has been made between the Greater Baltimore and native tomato, it being the hope that a large fruited tomato having the vigor of the native variety may be obtained.

In case of melons also, varieties from the States do very poorly, owing to their susceptibility to disease and their lack of adaptability

to Porto Rican conditions. Crosses have been made between introduced kinds and a large, very vigorous native muskmelon. A trial of from 4 to 8 hills each of several melon varieties, with 4 vines to the hill, gave the following results:

*Results of a trial of several melon varieties.*

Variety.	Number of fruits per hill.	Weight of fruits per hill.	Average weight of fruits.
		<i>Pounds.</i>	<i>Pounds.</i>
Native muskmelon.....	3.93	19.63	5.00
Berry muskmelon.....	4.50	4.53	1.01
Salmon Fin Pollock muskmelon.....	2.67	2.68	1.01
Flat Jenny Lind muskmelon.....	3.86	2.46	.64
Golden Hybrid cassaba.....	1.7	2.73	1.61
Winter Pineapple cassaba.....	2.0	2.42	1.21
Honey Dew cassaba.....	1.6	2.03	1.27
Hybrid cassaba.....	1.0	.86	.86
Fordhook Early watermelon.....	4.0	15.16	3.80
Baby Delight watermelon.....	2.5	6.91	2.77

A trial of a cross between the native white field corn and Early Adams sweet corn, obtained from P. G. Snyder, of Aibonito, gave an average of three ears, with a total weight of 13 ounces per hill of two stalks. The yield of this cross is very much poorer than that of native corn, though better than sweet corn varieties from the States. A trial of Oregon Evergreen sweet corn proved a complete failure. A fresh importation of white Cariaco corn from Venezuela has been made. This is the most satisfactory corn for table use that has been tried at the station.

A planting of Porto Rican grown potatoes was made to test the practicability of potato growing in the lowlands. Seed was also obtained from the Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry, United States Department of Agriculture, of the Portugese Red (S. P. I. 45023), a potato from Hawaii, supposed to be resistant to late blight and wilt.

#### GRAPEFRUIT.

Two kinds of work have been undertaken with grapefruit—bud selection and crossing. Tree records were kept for the past season on a grove near Pueblo Viejo. The trees in this grove are practically all of the Duncan variety, and range in age from 5 to 14 years. Trees of the same age are planted in the same block. Records were kept of the number of boxes of fruit per tree, approximate size of fruit, smoothness of fruit, and growing habit of tree. By use of these records the most valuable trees in the orchard may be found, and budwood can then be selected from them in order that desirable strains may be propagated. The notes on growing habit of trees were kept in order to determine whether there is a relation between



the habit of a tree of the Duncan variety and its value for fruit production. By the selection of budwood from the best trees, it is planned to obtain desirable strains which have a high, uniform yield, and small sized, smooth, high-quality fruit, borne in small clusters. In order that reliable data may be obtained, tree records should be kept over a period of several years. Nevertheless, in order that the work might be well started, five of the most promising trees were selected, the selections being based on the records for the preceding crop and the set of fruit for the new crop. Bearing budwood from these trees was budded into grapefruit stock in the station nursery. The value of this kind of work to the fruit grower has been demonstrated, and it is now known that the keeping of tree records, the subsequent elimination of drone trees, and the selection of budwood from the best trees, constitute a most important and profitable part of the orchardist's work.

During the spring bloom of 1919, about 100 reciprocal crosses were made between the Duncan and Triumph varieties. The seedlings from these crosses will be budded into bearing trees at an early age to hasten their fruiting. The Duncan and Triumph are two common commercial varieties in Porto Rico. The Duncan is commonly considered of higher quality and comes into bearing late in the season, being marketed usually from October to April or May. The Triumph, though not so desirable a fruit as the Duncan, is ready for market earlier and is quite resistant to the citrus scab, the most troublesome disease of citrus fruits in Porto Rico. Hybridization of these two varieties should be a very promising line of work.

#### BANANAS.

The Chamaluco banana, one of the important food plants of Porto Rico, is very susceptible to the banana wilt, or Panama disease. The description of this disease and of experiments carried on for its control have appeared in former reports of this station.<sup>6</sup> The methods tried for the control of this disease have offered little hope of success, with the possible exception of the development of a resistant strain. Work in this line was begun by the selection of the most healthy plants from a large, thoroughly diseased plat of bananas which were planted together in one part of the diseased plat. These selected plants, on reaching maturity, were much more vigorous and healthy than the adjacent plat of nonselected plants, despite the fact that a number of the selected plants had developed the disease. The entire banana plat was gone over, including selected and nonselected plants, and a new selection was then made of plants which showed no trace of disease. These, with their suckers, were planted in a section 70 by

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<sup>6</sup> Porto Rico Sta. Rpts. 1915, pp. 34-41; 1916, pp. 29-31.



150 feet of the diseased plat after the old diseased plants had been dug out, chopped into small pieces, and thoroughly worked into the soil, so that infected material was well distributed throughout. After a period covering three months of growth 39 plants, or 36.1 per cent of the planting, began to show the presence of the disease by the characteristic yellow color and gradual wilting of the leaves. Signs of disease shown at such an early stage are very unusual. Quite a number of the selected plants, however, are now vigorous and healthy, and some of them may prove to be really resistant.

#### SUGAR CANE.

The work with sugar cane has consisted in the production of seedling canes and of variety testing. A planting of cane, made in September, 1917, was used for the variety tests and as the source of arrows for planting. The planting was made primarily for the purpose of obtaining arrows, the varieties being arranged largely in single rows. The intention was to obtain arrows of the Otaheite variety, fertilized with pollen from pollen-fertile varieties, but inasmuch as the Otaheite proved practically a complete failure, due to the attacks of the mottling disease, this plan was abandoned. A few arrows of Otaheite were obtained from other localities.

The arrows were sown in seed boxes and covered with a thin layer of coconut fiber. Apparently, however, the coconut fiber hindered germination. This plan, therefore, is considered inferior to that whereby the arrows are covered with a very fine sifting of sand, and water is applied at frequent intervals. The use of manure water produced a slight increase of growth in the young seedlings over the use of ordinary water, the effect being most marked during the period before the first transplanting, which was from six to eight weeks.

The following table shows the varieties from which arrows were obtained, their relative abundance of arrow production, and the approximate relative germination of arrows from the different varieties:

*Relative production and approximate germination of arrows from different varieties of sugar cane.*

Variety.	Production of arrows.	Approximate germination.	Variety.	Production of arrows.	Approximate germination.
P. R. 260.....	Prolific.....	Fair.	P. R. 210.....	Medium.....	Excellent.
G. C. 1486.....	do.....	Very poor.	P. R. 292.....	do.....	Poor.
G. C. 1480.....	do.....	Poor.	D. 109.....	do.....	Excellent.
G. C. 1070.....	do.....	Very poor.	B. 3922.....	Scant.....	None.
M. P. R. 3.....	do.....	Do.	P. R. 318.....	do.....	Poor.
Kavangir0.....	do.....	Do.	G. C. 1454.....	do.....	Fair.
Java 36.....	do.....	Do.	Java 234.....	do.....	Very poor.
D. 117.....	do.....	Do.	Java 228.....	do.....	None.
P. R. 317.....	do.....	Fair.	G. C. 701.....	do.....	Very poor.
M. P. R. 4.....	Medium.....	None.	Otaheite.....	do.....	Do.



The seedlings, after being twice transplanted, were finally set in the field in June. About 800 seedlings are on hand at present, all of which show traces of the mottling disease, some very slightly.

The cane used in the variety test was harvested 16 months after it had been planted. Just before it was harvested notes were taken on varietal characters and on the prevalence of the mottling disease. Since the varieties were arranged in single rows, with the exception of the M. P. R. seedlings, only a rough comparison could be obtained, yet in many cases the difference in yield was great enough to be very significant. Tests for sucrose were made by the chemical department. The results of the variety test follow:

*Results of tests with varieties of sugar cane, showing relative difference in yield and prevalence of mottling disease.*

Variety.	Average yield per hole.	Calcu- lated yield per acre. <sup>1</sup>	Sucrose content.	Mottling disease.	
				Occurrence.	Damage. <sup>2</sup>
	<i>Pounds.</i>	<i>Tons.</i>	<i>Per cent.</i>		
Kavangire.....	95.9	83.56	12.2	Not noticeable.....	None.
B. 1753.....	75.0	.....	16.1	Abundant.....	Small.
G. C. 1480.....	60.0	52.27	17.2	Moderate to abundant.	Slight.
Java 36.....	59.8	42.13	17.25	Abundant.....	Do.
M. P. R. 3.....	55.7	48.56	15.3	.....do.....	Large.
B. 3412.....	44.4	.....	15.3	Moderate to abundant.	Bad in spots; other- wise slight.
B. 6450.....	44.1	38.38	17.1	Small.....	Apparently small; cane badly lodged.
P. R. 292.....	42.9	.....	14.7	Abundant.....	Moderate.
M. P. R. 4.....	40.3	40.44	14.9	.....do.....	Serious.
B. 4596.....	<sup>3</sup> 40.0	.....	12.0	Moderate to abundant.	Do.
G. C. 1070.....	39.3	34.23	16.1	Very slight.....	
G. C. 1486.....	38.2	33.27	15.3	Slight.....	Slight.
G. C. 1479.....	36.4	31.71	13.8	Abundant.....	Large.
P. R. 317.....	53.8	31.25	13.7	Moderate to abundant.	Small.
G. C. 1332.....	34.7	30.22	17.2	.....do.....	Do.
B. 3922.....	<sup>3</sup> 33.5	29.15	17.0	Abundant.....	Slight to moderate.
G. C. 1454.....	33.1	28.86	15.4	Slight to moderate....	Large.
Java 234.....	31.3	27.30	16.0	Abundant.....	Very serious.
D. 117.....	35.5	27.03	15.5	.....do.....	Serious.
G. C. 493.....	30.7	26.72	14.3	Fairly abundant.....	Do.
G. C. 701.....	27.3	23.74	16.5	Moderately abundant.	Do.
G. C. 1346.....	26.3	22.94	13.6	Abundant.....	Large.
D. 109.....	51.9	22.59	16.8	Moderately abundant.	Do.
G. C. 1419.....	30.8	22.32	15.4	Abundant.....	Do.
Java 228.....	25.5	22.16	16.8	.....do.....	Serious.
P. R. 260.....	47.1	21.90	14.0	Slight, if any.....	Not noticeable.
M. P. R. 2.....	22.6	19.71	15.1	Abundant.....	Large.
M. P. R. 1.....	20.8	18.08	.....	.....do.....	Do.
P. R. 318.....	32.3	16.41	15.0	.....do.....	Do.
B. 109.....	28.0	15.25	16.2	.....do.....	Serious.
P. R. 210.....	.....	15.06	15.4	.....do.....	Moderate to large.
P. R. 208.....	18.9	8.25	14.7	.....do.....	Large.
B. 347.....	16.8	.....	15.0	.....do.....	Very large.
P. R. 270.....	} (4)	(4) {	15.9	.....do.....	Serious.
P. R. 376.....			17.0	Complete.....	Large.
B. 208.....	(5)	.....	.....	.....	.....
M. P. R. 5.....	(5)	.....	.....	.....	.....
M. P. R. 6.....	(5)	.....	14.3	.....	.....
Otaheite.....	(5)	.....	.....	.....	.....
Seely seedling.....	(5)	.....	17.7	Abundant.....	Very large.

<sup>1</sup> Terms indicating the amount of damage by disease are used in the following order of increasing damage: Slight, small, moderate, serious, large, very large.

<sup>2</sup> In a few cases where the row length could not be determined, the yield per acre was not calculated.

<sup>3</sup> Outside rows.

<sup>4</sup> Harvested together by mistake.

<sup>5</sup> Failure.

By far the heaviest yielding cane is the Kavangire, a Japanese cane, which, in addition to producing immense stools of very slender canes, is resistant to the mottling disease. However, its juice is low in sucrose, and it is very difficult to harvest on account of its slender canes. For these reasons the Kavangire is not likely to find much favor as a commercial cane, but should be very valuable for use in breeding new varieties. The past season's trials indicate that it is practically self-sterile, and, consequently, adapted to cross-pollination with pollen-fertile varieties. Other promising varieties include B. 1753, G. C. 1480, G. C. 1486, and Java 36. The variety P. R. 260, which has been quite free from mottling disease, did not give a large yield. Notes were made of the extent of mottling disease on the ratoon growth seven months after the first crop was cut. The Kavangire and Java 36 are showing strong resistance. The varieties G. C. 1480, G. C. 1486, G. C. 1070, and G. C. 1454, are standing up moderately well, and a fair amount of resistance<sup>7</sup> is shown by M. P. R. 3, B. 3922, and Java 228.

#### BEANS.

The work in bean selection was continued, and from a planting made in February, 1919, yields were obtained for 25 selections of the black Venezuelan bean and 5 other nonselected varieties. The average yield of all black Venezuelan selections was 2,131.3 grams of beans per 70-foot row; the average yield of Santo Domingo brown was 1,129.1 grams per row, and of Porto Rican red 1,010.4 grams per row. The yields of White tepary, New Mexico pinto, and Mexican red were very poor. Additional plantings of black Venezuelan selections were made in March and in June.

Crosses were made between black Venezuelan and Mexican red and between the Porto Rican red and White tepary varieties, and first generation plants were grown. Owing to the ravages of the bean blight, these plants were almost destroyed, despite the fact they were frequently sprayed. A few seeds were obtained, however, and these were turned over to the horticultural department for planting.

#### CORN.

Thirty-six ears of corn of different types, which were obtained from several different localities through the agricultural extension department, were planted separately in late April and early May. These were harvested in August, and their best yielding rows were selected as a basis for future selection. The yields of rows with

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<sup>7</sup> The word "resistance" is here applied to varieties on which the disease may be prevalent, but which are not seriously injured thereby, as well as to those varieties which show only a slight amount of disease.



good stands ranged from 8 to 42 pounds per 100-foot row without the application of fertilizers, an equivalent of 14 to 72.6 bushels per acre.

An experiment has been begun for the purpose of studying the correlations existing between certain characters of plant and ear, the yield of grain, size of ear, and the length of season. The progenies of 10 ears have been selected for this work. They will be planted in 20 lots, each of which will be subjected to continued selection through a series of years for 2 characters of plant or ear, and the desired correlations will be determined for each generation. Each year the same characters are to be studied by securing the measurements of several hundred individual plants from a uniform lot of seed, and by correlating plant and ear measurements with the yield of grain from the same plants. During the present season, the work was begun by taking data on corn plants from unselected seed. Measurements were also made on the parent ears used for the ear-to-row tests mentioned above, and on plant characters of the progenies of 30 ears, from which correlations with yield of grain, size of ear, and length of season will be determined.

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## REPORT OF THE SPECIALIST IN FARM MANAGEMENT.

By H. C. HENRICKSEN.

The last annual report of the specialist in farm management dealt exclusively with emergency work in cooperation with other agencies. That work at the beginning of the fiscal year was left in charge of an assistant, although the writer kept in close touch with it until February, when it was discontinued. In addition to the propaganda for food production, several lines of investigation were conducted through the 40 field agents employed. As some of this work was interrupted by the discontinuance of the organization, a final report can not be submitted at this time.

### TIME OF PLANTING AND DISTRIBUTION OF ACREAGE OF SOME FOOD CROPS.

Questions dealing with time of planting and distribution of acreage of food crops were answered through the crop estimates received each month from September, 1917, to January, 1919, inclusive. The reports from the 12 months, November, 1917, to October, 1918, are probably the most reliable, and from them the following data have been tabulated:

*Corn* (80,000 acres planted).—Planting by months: February, 5 per cent; March, 14 per cent; April, 20 per cent; May, 21 per cent;



June, 6 per cent; August, 6 per cent; September, 12 per cent; October, 6 per cent; November, December, January, and July, inclusive, 10 per cent. These figures are fairly uniform for the whole island with the following exceptions: On the west end of the island, the September and October plantings amount to 50 per cent or more of the total for the Cabo Rojo to Ponce region. The Aguadilla-Isabela region also plants more in the fall. Twenty-five per cent of the total crops was produced in the Ponce to Cabo Rojo section, and another 25 per cent in the Aguadilla-Arecibo-Utuado triangle. The tobacco district Cayey, Caguas, Comerio planted about 4,000 acres. Yabucoa planted 1,500 acres, and Coamo 3,000 acres.

*Rice* (22,000 acres planted).—Planting by months: March, 4 per cent; April, 12 per cent; May, 27 per cent; June, 15 per cent; July, 18 per cent; August, 9 per cent; September, 8 per cent, and 7 per cent about equally divided between the other five months. The Yabucoa-Maunabo section had about 1,700 acres planted, and the municipalities of Barros, Cidra, and Cayey averaged about 1,000 acres each. The following municipalities ranged from 400 to 700 acres each: San Sebastian, Lares, Utuado, Villalba, Coamo, Ponce, Comerio, Bayamon, Aguas Buenas, Caguas, San Lorenzo, Rio Grande, and Carolina.

*Field beans and cowpeas* (118,000 acres planted).—In March, 13 per cent of the acreage was planted; in April, 18 per cent; in May, 15 per cent; and in September, 11 per cent. In June and July the plantings were light, and in the other months they were from 5 to 7 per cent of the whole each month. On the western end of the island the planting season appears to be earlier where a larger per cent than the averages was planted in January and February. In the Coamo-Juana Diaz-Ponce section the September plantings were heavier than the average. Isabela reported more than 7,000 acres, and Aguadilla, Aguas Buenas, San Sebastian, and Utuado reported more than 4,000 acres each. Arecibo, Hatillo, Lares, Ponce, and Yauco reported more than 3,000 acres each, and the following municipalities reported more than 2,000 acres each: Adjuntas, Cabo Rojo, Camuy, Carolina, Coamo, Moca, Quebradillas, and San German. Very few municipalities planted less than 500 acres, and the majority ranged from 500 to 1,500 acres. About 50 per cent of the acreage reported was planted to the white Navy type, 25 per cent or more was planted to what are called red beans, which included large and small Red Kidney and a number of types resembling such varieties as Horticultural, Red Valentine, etc. The cowpeas, planted for consumption and comprising nearly 25 per cent of the acreage, are chiefly of the Blackeye type.



*Pigeon peas* (23,000 acres planted).—Planting by months: February, 7 per cent; March, 13 per cent; April, 21 per cent; May, 15 per cent; June and September each, 9 per cent. In the Isabela-Aguadilla section planting was much scattered throughout the months March to October, and in the Bayamon-Guayanilla section the largest acreage was planted in January and February. The Aguada-Isabela-Utuado triangle planted 40 per cent of the total acreage, and the Cabo Rojo to Ponce section, 27 per cent. The Rincon-Mayaguez-Las Marias section planted about 2,000 acres, and the Bayamon-Guaynabo section 1,000 acres.

*Sweet potatoes* (55,000 acres planted).—The season for planting sweet potatoes was very evenly distributed among the 12 months, though in most places the plantings were light in December and January. The acreage was more or less uniform throughout the island. Few municipalities planted less than 300 acres, and the Isabela section planted nearly 3,000 acres.

*Yautias* (22,000 acres planted).—In February, 9 per cent of the acreage was planted; in March, 12 per cent; in April, 16 per cent; in May, 13 per cent; in September, 10 per cent; and from 5 to 6 per cent in each of the other months, nearly equally divided. In the municipality of San Sebastian the acreage was more than 1,000, but in most municipalities it ranged from 100 to 700. Some municipalities, such as Guanica, Lajas, Cabo Rojo, Santa Isabel, and Vieques, plant practically no yautias.

*Cassava* (14,000 acres planted).—The planting ranged from 800 to 900 acres in each of the months December, January, July, August, and October, and from 1,100 to 1,800 in each of the remaining months. The Aguadilla-Isabela section planted about 3,000 acres; Utuado, Guaynabo, and Bayamon, 500 each; Moca, San Sebastian, and Ponce, about 700 each. In other sections the plantings ranged from a few up to 300 acres in each municipality.

*Yams* (7,000 acres planted).—In January, 10 per cent of the total was planted; in February, 15 per cent; in March, 14 per cent; in April, 18 per cent; in May, 13 per cent; and 4 per cent in June. Practically none was planted in July, but from August to January the acreage increased gradually from 3 to 8 per cent. Aguadilla is the only municipality reporting more than 500 acres. Mayaguez, Moca, and Ponce reported nearly 400 acres each. San Sebastian and Utuado, more than 300 acres each, and Aguada, Anasco, Guaynabo, Lares, Las Marias, Quebradillas, and San German, more than 200 acres each. The acreage in the mountain districts east of Utuado was negligible. No yams are planted at any time in the drier sections on the west end of the island.

### EDUCATIONAL WORK.

Though many of the agricultural committees mentioned in last year's report discontinued the work outlined as soon as the field service stopped, others remained active and still correspond with this office. On the whole, the effect of the effort made is yet evident in most places.

The educational effort in behalf of tick eradication resulted in the building of many dipping tanks and aroused an island-wide enthusiasm which will greatly aid in making Porto Rico tick free. Assistance was given in formulating a bill authorizing an appropriation for tick eradication which was passed by the last legislature.

### CORN SELECTION.

During the earlier part of the year every field agent was requested to send in samples of corn from all districts of the island. Ears were received from about 100 localities and represented all types and colors grown. This corn was used as a basis for a lecture on corn selection. Later, as the subject became more clearly defined and the need of corn selection more apparent, a circular entitled "The Selection of Seed Corn in Porto Rico" was prepared and submitted for publication.

### POULTRY.

In the food propaganda carried on during the war, special emphasis was laid upon the necessity of bettering poultry, especially chickens. Information on poultry raising was widely circulated, and the result was very encouraging. This year a circular entitled "Poultry Keeping in Porto Rico" has been prepared and submitted for publication.

### AGRICULTURAL EXTENSION NOTES.

After the war-time agricultural work was discontinued, a special effort was made to keep in touch with at least a portion of the large rural population. For that purpose it was decided to publish timely information at short intervals. February 1 a start was made by sending out the first mimeographed issue which contained probably 1,000 words. Since then issues containing from 800 to 1,000 words, and written in English and Spanish have been sent on the 1st and 15th of each month to those who desired them. Up to the present time, however, it has been found difficult to maintain the mailing list, because many people who live far from a post office have never had mail delivered to them. This difficulty has been overcome by an arrangement which was made in the fall with all the school supervisors and



the special teachers of agriculture who have agreed to attend to the distribution of mail through the rural schools.

#### AGRICULTURAL LECTURES.

By the action of the last session of the legislature, the staff of special agricultural teachers was increased so as to provide one man for each school district except San Juan, which is entirely urban. This increase has proved a matter of very great importance to the island, for no other department is so closely in touch with the rural population. It will also prove of great importance to this office, as cooperative effort enables both the station and the school staff to gather much data and to disseminate knowledge among a class of people whom it would be difficult to reach in any other way.

It is manifestly impossible for one man to reach upward of a million people by word of mouth. Helpful suggestions to the special teachers of agriculture and the rural school teachers should, therefore, accomplish a great deal of good. Many people, however, do attend the fairs and agricultural meetings and take advantage of all opportunities which are offered them. By means of a light truck it has been found possible to carry for such purposes demonstration material of all kinds, including a projecting lantern and slides, charts, and sometimes a crate of purebred pigs, chickens, etc., as well as a good supply of literature for distribution.

#### FARM MANAGEMENT WORK.

As this branch of the station is in closer touch with fruit growers than with producers of any other export crops, being located in San Juan, it was natural that a farm survey should be first undertaken in the fruit districts. Very little was accomplished in the field until August 1, 1919, when a light truck was transferred to the station from the War Department and it became possible to carry out plans which had been pending for a long time. These plans comprise a survey of the fruit districts to determine the influence of soil, environment, and general treatment on stock and variety measured by the size and health of the tree and the quantity and quality of the fruit.

The financial aspect of citrus growing was taken up at the beginning of the fiscal year, but inasmuch as no one was found who could supply the necessary figures, a set of forms was prepared and a few samples sent out for trial. A number of helpful suggestions have been since received, and in a short time it will be possible to publish information which will answer local needs on cost accounting.

## REPORT OF THE AGRICULTURAL TECHNOLOGIST.

By W. A. MACE.

During the year investigational work was continued with rice, soy beans, and cowpeas. Work was also started with the mungo, or mung, bean (*Phaseolus mungo*). The planting of corn from the Virgin Islands did not prove a success last season. The yield was not so good as that from the selected seed of Porto Rican corn. The Virgin Islands corn is softer than the Porto Rican varieties and is much more readily attacked by weevils.

A large quantity of Napier, or elephant grass (*Pennisetum purpureum*), cuttings have been distributed among the planters of the island for propagation as a forage crop. Some of the planters have devoted large areas to this plant, which seems to be giving very satisfactory results. Napier grass is beginning to be considered of great value as a stock food, especially where dairying or stock raising is carried on, and it also serves as feed for work oxen on some of the sugar-cane plantations.

The spring planting of the rice nursery, where studies of the individual varieties and of cultural methods are made, was delayed this year, owing to the lack of water for flooding the field. However, it is hoped to make a late planting, and after this season to have an adequate water supply for carrying on this work so that two plantings can be made each year. Records showing date of seeding tests were continued, but conditions for making determinations have not been ideal, owing to insufficient water for keeping the plats flooded uniformly, and the records are, therefore, not entirely representative. The studies in rice irrigation have also had to be postponed. An irrigation system which it is hoped will supply sufficient water for carrying on the experimental work and for studying the different phases of rice culture necessary for the industry on the irrigable lands of Porto Rico is now in progress of construction by the station.

The total area of lands on the hillsides in Porto Rico, which are devoted to small plantings of rice, is of such proportion as to make important a study of the different varieties, conditions, and methods, with a view to improving this phase of the rice industry. For this reason, a collection has been made of the rices grown in the different parts of the island. These, numbering 145 samples, including numerous varieties, have been planted in a nursery at the station for study and comparison. In this nursery one variety of Honduras and one of Japanese rice are being used to serve as checks for this work. It is hoped to make another planting of these rices later in the season.



The rice work carried on with the planters in different parts of the island is being continued for making cultural tests and for demonstrating the use of machinery in this industry. While the plantings were not so numerous as those made last season, it is hoped that better general results will be obtained from this year's work.

Owing to the heavy rains of the summer it probably will be impracticable to use machinery, except on very rare occasions to harvest the spring crop. However, there is every reason to believe that the fall plantings can nearly always be handled with machinery. The only difficulty to be encountered in fall plantings is that of using the seeder in the rainy season, since the plantings must necessarily be made during the time when rainfall is heaviest. It is believed, however, that this can be worked out satisfactorily.

Variety tests, rate of seeding, and date of seeding tests are being carried on with cowpeas, soy beans, and mungo beans.

Good results have been obtained from the mungo, which seems of such importance as to be well worthy of further study both in regard to the plant and the various phases of culture necessary for its adoption as one of the principal food crops of the island. It is hoped that a large distribution of seed can be made for planting in the coming spring. This crop should prove to be very valuable to the small planter as it resists drought and excessive rains much better than the ordinary bean. It is hoped that it may attain the same position with the small planters here that it has attained in the Orient, where it is one of the principal food crops.

The dipping of the station cattle for the eradication of the cattle tick was continued with very satisfactory results. A large number of cattle from the vicinity of the experiment station have been brought in to be dipped and several dipping vats have been constructed on the island. Requests for information regarding the construction of vats and methods of procedure in the eradication of the tick are frequently received.















